Journal of Traumatic Stress, Vol. 17, No. 3, June 2004, pp. 195–202 (© 2004)

The Course of PTSD Symptoms Among Gulf War Veterans: A Growth Mixture Modeling Approach

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Relatively little is known about the course of PTSD symptoms over time following trauma exposure. Accordingly, this study utilized a specialized structural equation modeling approach, growth mixture modeling, to examine the trajectory of PTSD symptoms across three time points in a sample of Gulf War veterans (n at Time 1 = 2,949, n at Time 2 = 2,313, and n at Time 3 = 1,327). Results were most consistent with a two-group model suggesting that the course of PTSD symptoms following the Gulf War was best characterized by two distinct growth curves: (1) low levels of PTSD symptoms with little increase over time and (2) higher levels of initial symptoms with a significant increase over time. Thus, it appears that response to Gulf War experiences is not homogeneous, and that a subset of individuals may experience relatively more PTSD symptoms over time. In addition, men, Whites, those reporting more education, and those reporting less combat exposure had a significantly higher probability of being classified into the less symptomatic group.

KEY WORDS: PTSD; longitudinal; Gulf War veterans; growth mixture modeling.

Relatively little is known about the course of PTSD symptoms over time. Accordingly, the goal of this study is to utilize a specialized structural equation modeling approach, growth mixture modeling, to examine the trajectory of PTSD symptoms across three time points in a sample of Gulf War veterans.

On the basis of a review of studies that included measurement of PTSD symptoms on at least two occasions, it appears quite common to experience PTSD symptoms following trauma exposure. Estimates range from 14% (Herkov & Biernat, 1997) to 94% (Rothbaum, Foa, Riggs, Murdock, & Walsh, 1992) with most studies reporting that around 30% of the sample met criteria for PTSD within 3 months of the trauma (see e.g., Blanchard et al., 1996; Shalev et al., 1998). With respect to change across time, on average, rates of symptoms decrease across time (see e.g., Blanchard et al., 1996; Ehlers, Mayou, & Bryant, 1998; Shalev et al., 1998). Several studies, however, noted an increase in PTSD symptoms across time (see e.g., Southwick et al., 1995). Further, a substantial minority demonstrated a variable course across time during which symptomatic individuals improved and new cases developed (delayed onset) (e.g., Koren, Aron, & Klein, 1999; Mayou, Tyndel, & Bryant, 1997). Thus, PTSD symptoms may consist of varying trajectories across time.

The present study is designed to examine whether or not differing trajectories of PTSD symptoms exist in a sample of Gulf War veterans. On the basis of the existing literature, we predict two distinct trajectories, one with PTSD symptoms decreasing across time and one with PTSD symptoms increasing across time. If multiple trajectories exist within our sample, we will next examine whether or not we can predict group membership based on factors, such as gender.

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This study will examine the following variables as potential predictors of trajectory group membership: severity of trauma exposure, age, gender, race, education, military status, and military rank. Greater severity of trauma exposure is frequently observed to be predictive of increased severity and chronicity of PTSD symptoms (e.g., Goenjian et al., 2000). Women have consistently been found to experience more severe PTSD symptoms following trauma exposure (e.g., Breslau, 2000; Kessler, Sonnega, Bromet, & Nelson, 1995). Younger age (e.g., Kessler et al., 1995), ethnic minority status (e.g., Kulka et al., 1988; Ursano et al., 1999), and less education (e.g., Shalev, Peri, Canetti, & Schrieber, 1996) have all been found to be predictive of increased PTSD symptomatology. Finally, with regard to military status, nonactive duty personnel (i.e., Reserve and National Guard) called to the Gulf War reported experiencing more PTSD symptoms than active duty personnel (Stretch et al., 1996). In terms of military rank, enlisted personnel have been found to report more PTSD symptoms than officers (Adler, Vaitkus, & Martin, 1996).

Thus, the present study will examine the course of PTSD symptoms in a sample of Gulf War veterans and test the assumption that the sample will be best characterized by two trajectories of PTSD symptoms. In addition, this study will explore how strongly the predictors described above (e.g., severity of exposure) are related to trajectory of PTSD symptoms.

Method

Design and Procedure

Data for the present study were obtained from three waves of a longitudinal survey of Gulf War veterans. Within 5 days of the veteran's return to the United States from the Gulf War theater in 1991 (Time 1), the participants ($N = 2,949$ Army personnel at Ft. Devens, Massachusetts) completed paper-and-pencil surveys (see Wolfe, Brown, & Kelley, 1993, for a full description of the survey). The cohort represented a broad array of Army personnel, including those deployed from active duty ($n = 823$), as well from the Reserves ($n = 587$) and the National Guard ($n = 1,505$). Participants surveyed at Time 1 represented approximately 60% of the military personnel deployed from Ft. Devens to the Gulf region. The full cohort was recontacted twice over the subsequent years: at either unit meetings throughout New England or by mail in 1993–94 (Time 2) and again by mail in 1997–98 (Time 3). Written informed consent was obtained at all three times.

Participants

At Time 1, participants included 2,702 men and 240 women. The mean age was 30.06, with men significantly older than women. The average education level was 13.17 years, with women slightly more educated than men. Most of the cohort (82%) was White, with 9% Black, 4% Hispanic, and 5% designated as "other." Seventy-two percent were called from the Reserves or National Guard, and 92% were enlisted personnel.

At Times 2 and 3, roughly 78% and 44% of the original sample participated, respectively. To assess differences due to attrition, those responding at Time 2 and Time 3 were compared with nonresponders on a number of Time 1 variables (see Table 1). At Time 2, nonresponders were more likely to be younger, of minority status, and deployed from active duty. At Time 3, nonresponders were more likely to be younger, of minority status, deployed from active duty, and male, and less likely to have reported prior combat service at Time 1. Importantly, being a responder or nonresponder at Time 2 or Time 3 was not significantly related to Time 1 PTSD symptoms. Thus, there were no differences in attrition as a function of Time 1 PTSD symptoms.

Measures

Participants completed a number of self-report measures assessing background information, experiences in the Gulf, and psychological outcomes. Demographic and background variables included gender, age, race, education, military status, and military rank.

Gulf War combat exposure was assessed with the Laufer Combat Scale (Gallops, Laufer, & Yager, 1981), augmented with items specific to the Gulf War (e.g., being on alert for SCUD or biochemical attack; Rosenheck et al., 1991). This measure was comprised of 33 items scored based on a 3-point Likert response format: 0 = *never*, 1 = *once or twice*, and 2 = *three or more times* which were summed based on 0 = *didn't happen* or 1 = *happened* to create a total combat exposure score (range 0–33). It was designed to assess a range of combat (or potentially distressing combat-related) experiences and includes items such as, "Were you exposed to poison gas or germ warfare?," "Were you involved in handling dead bodies away from the battlefield?," and "Did your unit suffer training accidents?" The reliability and validity of the Laufer scale has been well-established (Gallops et al., 1981). The coefficient alpha was .73.

Table 1. Responder and Nonresponder Comparisons on Demographic and Background Variables, Combat Exposure, and PTSD Symptoms Reported at Time 1

	Valid at Time 1		Valid at Time 2		Valid at Time 3		Comparisons with responders	
Time one variable	*M* (*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)	*N*	Time 2 nonresponders	Time 3 nonresponders
Female	0.08 (0.27)	2,942	0.08 (0.28)	2,309	0.09 (0.29)	1,283	$\chi^2(1) < 1$	$\chi^2(1) = 4.39^*$
White	0.83 (0.38)	2,942	0.86 (0.35)	2,309	0.89 (0.31)	1,283	$\chi^2(1) = 56.05^{***}$	$\chi^2(1) = 65.49^{***}$
Reserve/national guard	0.72 (0.45)	2,912	0.79 (0.41)	2,288	0.77 (0.42)	1,271	$\chi^2(1) = 256.65^{***}$	$\chi^2(1) = 26.33^{***}$
Officer	0.08 (0.27)	2,912	0.08 (0.27)	2,282	0.09 (0.28)	1,271	$\chi^2(1) < 1$	$\chi^2(1) = 2.31$
Education (in years)	13.17 (1.80)	2,930	13.19 (1.84)	2,303	13.35 (1.90)	1,281	$t(2932) = -1.11$	$t(2932) = -4.69^{***}$
Age (in years)	30.06 (8.41)	2,880	30.47 (8.75)	2,280	31.88 (8.95)	1,267	$t(2878) = -5.03^{***}$	$t(2878) = -10.49^{***}$
Previous combat service	0.12 (0.32)	2,867	0.12 (0.33)	2,254	0.14 (0.35)	1,256	$\chi^2(1) = 2.51$	$\chi^2(1) = 13.69^{***}$
Combat exposure	6.96 (4.97)	2,929	6.91 (4.94)	2,301	7.00 (4.80)	1,279	$t(2934) = 1.26$	$t(2934) < 1$
PCL time 1	1.36 (0.36)	2,907	1.36 (0.36)	2,284	1.36 (0.36)	1,275	$t(2911) < 1$	$t(2911) < 1$
M-PTSD time 1	61.89 (13.35)	2,907	61.85 (13.29)	2,284	61.65 (13.37)	1,275	$t(2911) < 1$	$t(2911) < 1$

Note. M-PTSD = Mississippi Scale for Combat-Related PTSD. Combat exposure scale is a total score with higher scores indicating more combat exposure. PCL at each time is the mean score on the PTSD Checklist (range is from 1 to 5 with higher scores indicating higher symptom reporting). $^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

PTSD symptoms were assessed at the three times using at least one of two popular measures—the extended version of the Mississippi Scale for Combat-related PTSD (M-PTSD) (Keane, Caddell, & Taylor, 1988) or the PTSD Checklist (PCL; Weathers, Litz, Herman, Huska, & Keane, 1993). The M-PTSD is comprised of 39 items scored using a 5-point (1–5) Likert scale. In the present study, minor wording changes were made to reference the Gulf War context (Wolfe et al., 1993). The M-PTSD is a reliable and valid self-report measure with excellent sensitivity (.93) and specificity (.89) with clinical diagnoses of PTSD (Keane et al., 1988). The PCL is comprised of 17 items (scored using a 5-point, 1–5, Likert scale) that were directly derived from the 17 PTSD symptoms in the *DSM-IV* (APA, 1994). This scale has demonstrated excellent reliability and validity, and is both sensitive and specific when deriving a clinical diagnosis of PTSD (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996).

At the beginning of this project the M-PTSD was considered the gold standard for self-report measures, however, shortly after the project began, the PCL was developed. Given the shorter length of the PCL and the direct concordance between the PCL and the *DSM-IV*, we replaced the M-PTSD with the PCL. As a result, the M-PTSD was administered at Time 1 and Time 2 and the PCL was administered at Time 2 and Time 3. Given the current analyses use mean and variance information, it was necessary to have a PTSD symptom score in a common metric across time. Thus, we used information from Time 2 (when both PTSD scales were administered) to rescale the M-PTSD at Time 1 to a common metric as the PCL using standard OLS regression techniques. Any possible limitations due to this technique are covered extensively in the discussion.

Results

Means and standard deviations of all study variables are reported in column 2 of Table 1. In addition, the means (*SD*s in parentheses) for the PTSD measures at all time points are as follows: M-PTSD at Time 1 = 61.90 (13.35), Estimated PCL at Time 1 = 1.36 (.36), M-PTSD at Time 2 = 66.76 (17.51), PCL at Time 2 = 1.47 (.60), and PCL at Time 3 = 1.84 (.80).

Growth Mixture Model Analyses

Growth curve modeling allows one to test whether the rate of change of PTSD symptoms across multiple time points is significantly different from zero. Specifically, do PTSD symptoms increase or decrease significantly across three time points? In traditional latent growth curve modeling, structural equation modeling is used to estimate a growth curve that is comprised of an intercept and slope, similar to a regression equation. This study employed growth mixture modeling, a cutting-edge statistical technique that combines traditional latent growth curve analysis with latent class analysis. Growth curve analysis attempts to fit one growth curve to the entire sample while growth mixture modeling tests whether or not the sample is comprised of more than one group (or class) of individuals who have distinctly different growth curves. If there are distinct groups in our data (e.g., one group that improves significantly and one group that deteriorates significantly), we lose information (and potentially mischaracterize the sample) by fitting one growth curve to the sample. Using growth mixture modeling, we can test whether or not the change in PTSD symptoms is best characterized by one or more distinct growth curves. In addition, if our sample is

best characterized by more than one growth curve, growth mixture modeling allows us to examine whether or not we can predict or characterize our distinct subgroups using variables such as gender.

Determining the Number of Distinct Subgroups

The first step was to determine whether or not the sample was best characterized by multiple growth curves. Three separate and independent models (a one-group model, a two-group model, and a three-group model) were estimated and compared to determine which represented the best fit to the data.[5] A best-fitting model was chosen based on the Bayesian information criterion (BIC), the standard statistic used for model selection with this procedure; a lower value indicates a well-fitting model. The BIC was 7,887.26 for the one-group model, 5,473.82 for the two-group model, and 6,510.33 for the three-group model. On the basis of the BIC statistic, the two-group model provides the best fit suggesting that the data is best characterized by two distinct growth curves (see Table 2). In addition to the BIC statistic, calculation of posterior probabilities provides an indication of the quality of classification provided by the two-group model.[6] Specifically, individuals who were in the first group, had a 90% posterior probability of being classified into the first group and only a 7% posterior probability of being classified into the second group. Similarly, individuals who were assigned to the second group, had a 93% posterior probability of being classified into the second group and only a 10% posterior probability of being classified into the first group. Thus, individuals were much more likely to be classified into their originally assigned group, based on posterior probabilities, than the alternate group, suggesting that the quality of classification in this model was high.

Given that the sample is best characterized by two distinct trajectories of PTSD symptoms across time, how do the trajectories of these two groups differ (see Fig. 1)? Fifty-seven percent of the sample was assigned to the first group which was relatively less symptomatic. This first group had lower initial PTSD symptomatology at Time 1, flatter slope (i.e., less increase in symptoms across time), and the slope and intercept were not significantly correlated (i.e., one's initial value of PTSD symptoms was not significantly related to their trajectory across time). Forty-three percent of the sample was assigned to the second group which was relatively more symptomatic. The second group had higher initial PTSD symptomatology at Time 1, steeper slope (i.e., greater increase in symptoms across time), and the slope and intercept were significantly correlated (i.e., a higher initial level of PTSD symptoms was significantly related to a greater increase in PTSD symptoms across time). Thus, the present data suggest that response to Gulf War experiences is not homogeneous and PTSD symptomatology is best represented by two distinct growth curves. Moreover, the present data suggest that one group of individuals is relatively more symptomatic and experienced an increase in PTSD symptomatology across time as compared to the less symptomatic class.

Table 2. Intercept and Slope Statistics, Residuals, and Posterior Probabilities From Unconditional Growth Mixture Model

	Group 1 (less symptomatic)	Group 2 (more symptomatic)
Intercept mean (critical value)	1.14 (88.65)	1.61 (24.95)
Intercept variance (critical value)	0.01 (2.53)	0.01 (2.53)
Slope mean (critical value)	0.04 (1.32)	0.20 (15.89)
Slope variance (critical value)	0.00 (1.72)	0.00 (1.72)
Correlation between intercept and slope	0.00 fixed	0.02 (2.986)
Proportion of sample	57%	43%
Residual for PCL at time 1	0.02	0.14
Residual for PCL at time 2	0.02	0.41
Residual for PCL at time 3	0.03	0.48
Posterior probability of being classified in group 1	90%	7%
Posterior probability of being classified in group 2	10%	93%

Note. Bayesian Information Criteria for model is 5,473.82. $N = 2913$. PCL = PTSD Checklist.

Prediction of Group Membership

Given that the course of PTSD symptomatology following the Gulf War was best described by a two-group model, we then progress to our second question, specifically, are we able to predict who is more likely to be assigned to the less symptomatic group as opposed to the more symptomatic group? Gender, race, education, combat exposure, military status, military rank, and age were entered simultaneously as possible predictors of group membership. Four variables, gender, race, education, and combat exposure, were significant predictors of class

[5] Each of the models shared a number of features: the three PTSD scores were used to extract an intercept and a slope latent variable, the intercept and slope were allowed to freely covary, error covariances were constrained to zero, and a linear growth curve (with respect to time) was fit using maximum likelihood estimation and parameters were estimated using all available data (missing data was assumed to be missing at random and was thus included in the parameter estimates). For additional examples of this technique, see Muthen and Muthen (1998) and Muthen et al. (2002).

[6] After the model parameters have been estimated, posterior probabilities for each individual and class can be computed. For each individual, they refer to the probability of being in a certain class given the estimated model and the individual's values on the observed values.

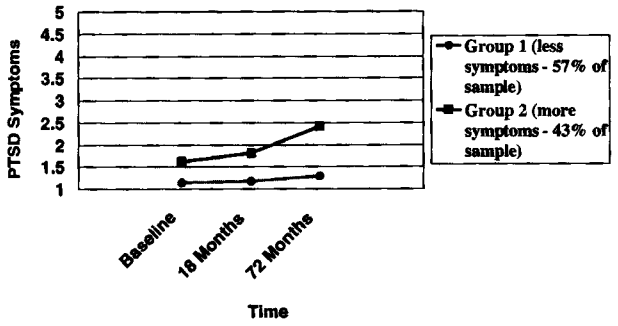

Fig. 1. Course of PTSD symptoms across three time points for the less symptomatic (Group 1) and more symptomatic (Group 2) groups of Gulf War veterans.

membership based on critical ratios (CR), comparable to a *t* statistic, greater than 1.96. Men (CR = 4.41), Whites (CR = 1.98), those reporting more education (CR = 4.28), and those reporting less combat exposure (CR = 8.14) were more likely to be assigned to the less symptomatic class. For men, the probability of being in the less symptomatic group was .69, whereas the probability of being in the more symptomatic group was .31 (with all other variables in the model at zero). For White participants, the probability of being in the less symptomatic group was .57, whereas the probability of being in the more symptomatic group was .43 (with all other variables in the model at zero). For the two significant continuous variables (combat exposure and education), the odds ratio of being in the less symptomatic group is .41 as combat exposure increases and 1.13 as years of education increases (with all other variables in the model held constant).

Discussion

The present prospective study demonstrated heterogeneity in the course of PTSD symptoms during the 6-year period following the Gulf War. Specifically, within the present sample, the course of PTSD symptoms following the Gulf War was best represented by two distinct trajectories. The first trajectory, representing 57% of the present sample, was best described as low levels of PTSD symptoms with little increase over time (i.e., less symptomatic group). A second trajectory, however, appeared to characterize 43% of the present sample and included higher levels of initial symptoms with a significant increase over time (i.e., more symptomatic group). Further, for individuals in the more symptomatic group, higher levels of initial symptoms were significantly associated with steeper increases over time. The variability in course of PTSD symptoms across time suggests that there may be individual differences that can be explored to better understand the course of PTSD symptoms.

This study explored seven individual difference variables (i.e., combat exposure, military status, military rank, gender, race, age, and education) as possible predictors of the trajectory of PTSD symptoms. Our findings revealed that women, those of minority racial/ethnic status, those with less education and those reporting more exposure to combat had a higher probability of being in the more symptomatic group, as opposed to the less symptomatic group, of veterans.

The majority of prospective studies examining a range of traumas (e.g., sexual assault, military, disaster) find that PTSD symptoms decrease across time. However, several studies have reported an increase in PTSD symptoms across time, one of which is also a study using Gulf War veterans (Southwick et al., 1995). Further, a number of studies report a variable course of symptoms following trauma exposure where some individuals experience a decrease in symptoms and others experience an increase or delayed onset. Thus, the present findings are consistent with the literature demonstrating a variable course in PTSD symptoms across time. One aspect of the present findings that appears aberrant from the extant literature is the lack of finding a group of individuals with decreasing symptoms. What might account for the finding that PTSD symptoms increased across time in this sample of Gulf War veterans? There are several factors that may play a role. First, although veterans were surveyed immediately following their return from the Gulf War, this represents a variable window of time between trauma exposure and our data collection at Time 1 if we assume that a trauma exposure may have occurred immediately upon deployment. Although we do not know when trauma exposure occurred, the average time elapsed between deployment and the Time 1 interview was 19.17 weeks (with a range of 3.7–51.86 weeks). Thus, this variable window may have allowed for the initial decrease in PTSD symptoms that is usually seen within three months of the trauma exposure. Second, Orcutt, Erickson, and Wolfe (2002) found in the present data set that individuals who reported higher levels of combat exposure at Time 1 reported experiencing higher levels of additional trauma exposure (e.g., assault, accidents) between Time 1 and Time 2, and that this relationship was partially mediated by levels of PTSD symptoms. Thus, the increase in PTSD symptoms may represent the impact of cumulative trauma exposures for some individuals. Finally, Gulf War veterans may have been uniquely retraumatized by the controversy concerning Gulf War illness. Specifically, individuals in the present data set who begin experiencing medical problems subsequent to deployment may experience those

symptoms as potentially traumatic, thus resulting in an increase in PTSD symptoms.

This study identified a number of variables that were predictive of group membership. The most robust predictor was reported level of combat exposure. Individuals who reported higher levels of combat exposure during the Gulf War were more likely to be classified into the more symptomatic group. These findings are consistent with the literature supporting a dose-response relationship between exposure and PTSD symptoms (see e.g., Kaylor, King, & King, 1987).

Gender also emerged as a robust predictor of group membership. Women had a higher probability of being classified in the more symptomatic group. Although in general, men have been found to have higher rates of trauma exposure, women have consistently been reported to have a higher conditional risk of PTSD following trauma exposure, that is, following a trauma exposure, women are at higher risk than men of developing PTSD (Breslau, 2000). Consistent with this pattern, in the present study, although men and women did not significantly differ in their level of reported trauma exposure during the Gulf War (based on supplemental analyses), women appear to be at higher risk of experiencing PTSD symptoms than men following the Gulf War. In addition, the present findings are generally consistent with the literature suggesting that the duration of PTSD is longer in women than men (Breslau, 2000). One potential explanation for this increased risk may lie in the impact of cumulative trauma. Women appear to have significantly higher conditional risk of PTSD following assaultive violence than men, particularly rape and sexual assault (Breslau, 2000). A history of prior exposure to assaultive violence has been linked to increased conditional risk of PTSD following a new trauma exposure (Breslau, 2000). Given that female veterans have been found to have experienced high rates of childhood physical and sexual abuse (Merrill et al., 1999), exposure to sexual assault prior to entering the military (or during the military) may leave a subset of women more vulnerable than men to experiencing PTSD symptoms following additional trauma exposure, such as combat during the Gulf War. Further, it is important to note that the lack of significant gender differences in reported trauma exposure, does not eliminate the possibility that men and women may have experienced qualitatively different forms of trauma during the Gulf War (i.e., women may have experienced more sexual harassment and sexual assault while on duty).

Consistent with previous findings (e.g., Kulka et al., 1988), race emerged as a significant predictor of PTSD symptoms following the Gulf War. Members of a minority group (primarily Blacks and Latinos) were more likely to be classified into the more symptomatic group. Importantly, however, the vast majority of the sample in the present study is White (82%), and we lacked sufficient statistical power to examine the non-White groups individually. Some evidence suggests, however that the risk of PTSD for Latinos following trauma exposure is similar to Whites, whereas the risk for Blacks may be somewhat higher (Kessler et al., 1999). Thus, the inclusion of diverse sample large enough for specific comparisons is critical when examining the relationship of race and ethnicity to PTSD symptoms. Furthermore, race differences may often represent a proxy for differences in socio-economic status or education, and we cannot rule out these alternative explanations. Future research is needed to understand the processes underlying the increased risk of PTSD among members of some minority groups.

Consistent with previous findings, less education was associated with increased risk of PTSD symptoms (Kessler et al., 1995; Shalev et al., 1996). Level of education, as with race differences, likely represents a host of complex sociological processes that are difficult to tease apart when exploring the relationship between PTSD risk and educational attainment. In addition, despite previous findings that nonactive duty personnel (i.e., Reserve and National Guard) called to the Gulf War reported experiencing more PTSD symptoms than active duty personnel (Stretch et al., 1996), and enlisted personnel were found to report more PTSD symptoms than officers (Adler et al., 1996), military status and military rank did not significantly predict group membership. Further, age was not related to group membership.

Several limitations to the present findings should be noted. First, it is unclear to what extent the present findings generalize to other nonveteran samples and other trauma exposures, and future studies might productively employ this statistical methodology to examine the course of PTSD symptoms with other samples and trauma exposures. Second, this study employed PTSD symptoms and did not examine the trajectory of *DSM-IV* PTSD diagnosis per se. Although we discuss differences in the two groups in terms of PTSD symptoms, it should be noted that, overall, the sample is experiencing low levels of PTSD symptoms. In the future, it would be of interest to expand the present design to examine PTSD diagnosis as well as symptoms. Third, as noted above, the present data are self-report and have not been verified against any other report (e.g., military, significant other). This is particularly important in light of concerns of potential overreporting of symptoms in veteran samples (King et al., 2000). Fourth, the change in measurement from the M-PTSD to the PCL at Time 2 was not ideal and represents a limitation of the

present study. Using the data at Time 2, when both measures were present, we developed a linear transformation to estimate the PCL from the M-PTSD and felt confident in our ability to do so (i.e., the estimated PCL at Time 2 was correlated .85 with the actual PCL). Further, because we were interested in changes across time, we felt it was preferable to estimate the PCL at Time 1 (the start point of our model) as opposed to the M-PTSD at Time 3 (the end point of our model). Fifth, our sample was primarily White men. Given the important findings for gender and race differences, it is imperative that future studies contain more variability on those demographic variables. Sixth, the use of three time points limits the complexity of the growth curve that can be fitted to the present data; additional time points would allow for the exploration of more complex (e.g., nonlinear) trajectories. Finally, although we are employing state-of-the-art statistical methodologies to minimize bias in our parameters, our response rate at Time 3 was 44% resulting in a significant amount of missing data. This raises important concerns in interpreting the present findings. Although nonresponders at Time 2 and Time 3 did not significantly differ from responders on Time 1 levels of PTSD symptomatology and reported combat exposure, we cannot rule out the possibility that individuals who do not have full data on all three waves differed in a systematic manner from responders, and therefore our findings may not be representative of the general population of Gulf War veterans. Replication of the present findings is necessary to increase our confidence in the patterns observed in this sample. Of note, the growth mixture analyses were initially conducted only among the respondents with full data on all three waves ($n = 1,034$) (because an earlier version of Mplus did not yet have the more optimal option of using all available data as opposed to listwise deletion), and the basic findings were unchanged. Further, the present findings should be extended through the inclusion of additional instruments, samples, and trauma exposures.

In conclusion, the present findings represent an exciting application of a novel statistical approach, growth mixture modeling. The results of this study represent one of the first efforts to model PTSD symptoms across time using latent growth curve modeling and latent class analysis. The present results suggest that the course of PTSD symptoms following the Gulf War is variable across a 6-year period. Further, women, members of racial/ethnic minority groups, and those reporting more combat exposure were at increased risk of experiencing PTSD symptoms following the Gulf War. Identifying groups at risk for developing PTSD symptoms is essential for guiding treatment and prevention efforts following trauma exposure.

Acknowledgments

This research was supported by the Department of Veterans Affairs National Center for PTSD and the VA's Mental Health Strategic Healthcare group. We also thank Susan Proctor and Scott Pickett for their assistance.

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